THE WESTERN AUSTRALIAN

NATURALIST

Vol. 31 No. 2 May 25, 2018

Swamp Harriers (*Circus approximans*) are possible predators of Tiger Snakes at Herdsman Lake.

Photo: Warren Dell.

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Print Post Approved
PP 6358 23/00015
ISSN 0726 9609

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THE WESTERN AUSTRALIAN NATURALIST
(Journal of the W.A. Naturalists' Club)

Editor
MR JOHN DELL

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THE WESTERN AUSTRALIAN

NATURALIST

Vol. 31 25th May 2018 No. 2

EXTENSION OF COUNTS OF CARNABY'S COCKATOO *(CALYPTORHYNCHUS LATIROSTRIS)* AT TWO OVERNIGHT ROOSTING SITES IN METROPOLITAN PERTH

By P.F. BERRY (padberry1@westnet.com.au)

and

M. OWEN (goffmarg@bigpond.net.au)

ABSTRACT

Counts of Carnaby's Cockatoo are reported at overnight roosting sites centred at Hollywood Hospital and Perry Lakes in the Western Suburbs over 12 and 10 consecutive years respectively. A clear trend in seasonal abundance was apparent over the period recorded. After a rapid progressive increase starting in December, mean monthly numbers peaked in March or April at Hollywood, between March and June at Perry Lakes and for the two sites combined between March and May. This was followed by a rapid decline with lowest numbers of birds recorded from September to November. Daily counts ranged from 0 to over 600 but monthly means were similar between years. A slight increasing trend in numbers of Carnaby's Cockatoo roosting at the Western Suburbs roost sites is apparent over the last 10 years. Flocks at Hollywood comprised approximately 60% pairs and 40% triplets (pair and fledged young that was still being fed), but these proportions changed progressively to just over 70% for pairs and 30% for triplets as the cockatoos started to leave the Swan Coastal Plain. Clearing of native vegetation and vehicle strikes continue to be a potential threat to Carnaby's Cockatoo. The possible impacts of the recent increase in the Forest Red-tailed Black Cockatoo and Australian White Ibis in the Metropolitan area are discussed.

INTRODUCTION

Carnaby's Cockatoo (*Calyptorhynchus latirostris*), which is endemic to S.W. Australia, is currently recognized as threatened under both State and Commonwealth legislation due to a rapid decline in its numbers and distribution associated with land clearance in the Wheatbelt and the Swan Coastal Plain (S.C.P). According to Shah (2006) there has been a 50% decrease in its abundance and distribution over the last 45 years.

A highly gregarious and mobile species, Carnaby's Cockatoo breeds largely in the Wheatbelt and moves to the Swan Coastal Plain to feed in the non-breeding season (Davies 1966), (Saunders 1977, 1980, 1990), (Saunders and Ingram 1998) and Storr and Johnstone 1998. However, more recent studies by Johnstone *et al* (2005) indicate that this cockatoo is responding to reduction of its Wheatbelt habitat by movement further westward and southward with breeding now recorded at several localities on the S. C. P., including within the Perth metropolitan area.

Counts of Carnaby's Cockatoo at two overnight roosting sites centred on Hollywood Hospital and Perry Lakes in the Western Suburbs of Perth have been published previously (Berry 2008 and Berry and Owen 2009). These counts were made between April 2006 and August 2009 at Hollywood (41 consecutive months) and at Perry Lakes from February 2008 to August 2009 (19 consecutive months). Here we present the results of an extension of these counts at both sites from September 2009 to October 2017 – 84 additional months, bringing the total data set for the Hollywood site to 137 consecutive months (12 consecutive years) and for the Perry Lakes site to 103 consecutive months (10 consecutive years).

METHODS

The background to this study and the methods used to count Carnaby's Cockatoo have been described previously (Berry 2008).

Counts were made daily (as far as practical) to produce monthly averages.

RESULTS

Counts

There is a clear trend of mean and maximum seasonal abundance throughout the period recorded (Fig. 1 and Tables 1, 2 and 3). After a rapid progressive increase starting in December, mean monthly numbers peaked in March or April at Hollywood, between March and June at Perry Lakes and between March and May for the two sites combined. This was followed by a rapid decline with lowest numbers of birds recorded from September to November (Fig. 1). Maximum numbers of birds were recorded at the Hollywood site from January to May, at Perry Lakes

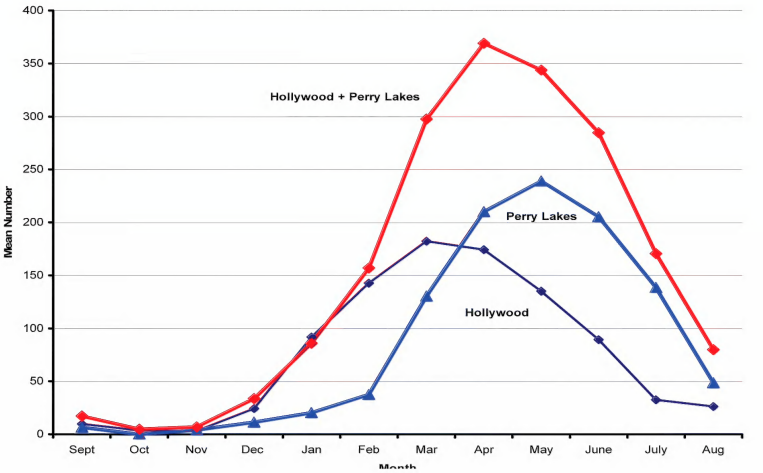

Figure 1. Summary of counts of Carnaby's Cockatoos at Hollywood (April 2006–Aug 2017), Perry Lakes (February 2008–Aug 2017) and the two sites combined ((February 2008–Aug 2017). (See Table 3).

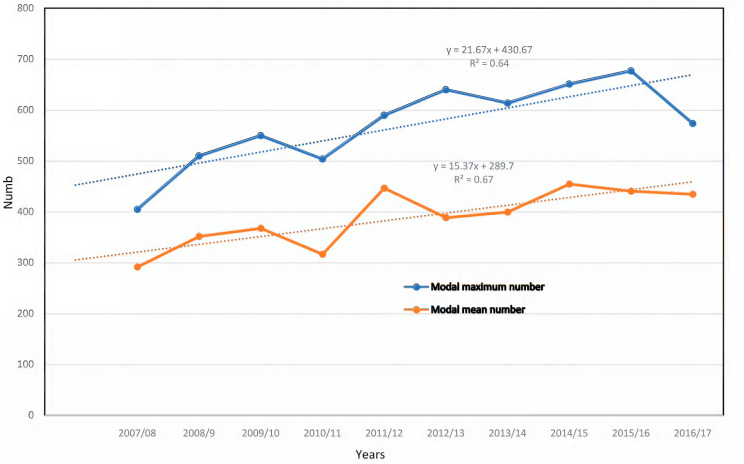

Figure 2. Annual mean and maximum modal numbers of Carnaby's Cockatoo counted over 10 years for the Hollywood and Perry Lakes roost sites combined (see Table 3).

from March to May and at the two sites combined from March to June. Monthly counts at the roosting site near Perry Lakes show an increase in numbers with a corresponding decline at the Hollywood site. This indicates that a progressively increasing proportion of the local cockatoo population roosts at the Perry Lakes site in autumn and winter. The mean numbers counted at both roosting sites combined show that a popu-

Table 1. Roost counts of Carnaby's Cockatoos at overnight roosting sites at Hollywood (April 2006–August 2017. (Numbers in brackets = days counted. Bold typeface = maximum numbers in each year).

MONTHS	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
HOLLYWOOD MEAN												
2006								**222**	205	63	27	0
2006/07	0	0	6	54	138	203	**291**	161	72	97	9	0
2007/08	0	0	3	25	102	176	**197**	109	18	58	24	1
2008/09	0	0	19	33	119	138	209	**262**	129	89	41	98
2009/10	98	38	2	27	94	187	**212**	145	98	28	11	0
2010/11	0	0	0	50	123	132	91	75	**147**	113	42	1
2011/12	0	0	0	6	61	121	122	210	**238**	141	17	2
2012/13	0	0	2	11	79	118	**262**	114	105	70	39	41
2013/14	0	0	0	10	84	97	137	183	**215**	82	0	1
2014/15	7	0	1	17	68	112	154	**264**	145	106	3	0
2015/16	0	0	0	32	106	134	185	**263**	146	105	6	0
2016/17	3	0	0	4	37	152	145	131	**174**	96	166	144

Mean	10	4	3	24	92	143	182	178	141	87	32	24
Median	0	0	1	25	94	134	185	172	146	93	21	1
Max.	98	38	19	54	138	203	291	264	238	141	166	144
Min.	0	0	0	4	37	97	91	75	18	28	0	0
HOLLYWOOD MAXIMUM												
2006								250 (5)	**450** (29)	239 (21)	166 (16)	2 (17)
2006/07	0 (26)	4 (31)	37 (18)	183 (26)	230 (19)	321 (26)	**676** (21)	387 (22)	233 (23)	339 (15)	60 (17)	0 (17)
2007/08	0 (17)	0 (15)	16 (17)	98 (24)	**331** (24)	**331** (25)	319 (23)	256 (29)	232 (25)	119 (18)	78 (25)	10 (25)
2008/09	0 (20)	0 (26)	34 (10)	69 (30)	254 (25)	368 (27)	473 (23)	**479** (25)	325 (28)	311 (30)	137 (28)	188 (29)
2009/10	186 (24)	131 (25)	11 (22)	87 (27)	236 (29)	292 (25)	460 (27)	**500** (29)	176 (27)	82 (30)	33 (29)	0 (31)
2010/11	0 (29)	0 (31)	0 (28)	161 (22)	279 (27)	**282** (26)	240 (29)	231 (13)	267 (22)	222 (28)	179 (16)	13 (30)
2011/12	0 (7)	0 (31)	4	22 (14)	176 (16)	250 (16)	288 (22)	**310** (15)	294 (17)	303 (25)	66 (17)	11 (17)
2012/13	0 (30)	0 (25)	16 (23)	31 (13)	181 (18)	145 (17)	**498** (24)	223 (9)	364 (27)	234 (16)	128 (10)	164 (20)
2013/14	0 (13)	0 (30)	0 (30)	44 (15)	171 (11)	214 (18)	**348** (17)	252 (8)	291 (6)	144 (14)	0 (30)	5 (14)
2014/15	53 (27)	0 (10)	8 (6)	35 (9)	169 (10)	286 (14)	336 (14)	**394** (11)	340 (11)	215 (17)	18 (11)	2 (13)
2015/16	0 (11)	2 (12)	7 (16)	64 (6)	263 (10)	215 (10)	**474** (16)	414 (13)	278 (14)	180 (15)	68 (19)	0 (22)
2016/17	15 (11)	0 (26)	0 (25)	15 (14)	124 (12)	257 (13)	289 (12)	263 (7)	**299** (20)	166 (11)	219 (19)	227 (28)

lation of around 250–300 birds is present in the Western Suburbs for at least four months of the year (March to June) and over around 150 birds for at least 6 months (Feb. to July) However, between March and June, maxima ranged between about 400 and 600 birds. (Table 3).

Our data show a slight increasing trend in the modal mean and maximum numbers of Carnaby's Cockatoo roosting at the Western Suburbs roost sites over the last 10 years (Fig. 2). The modal maximum numbers, are not as good an indicator as the mean, being based on single counts each month which probably include transient flocks, whereas the means are based on numerous counts. The increasing trend in mean modal numbers was more evident at Perry Lakes than at Hollywood (Tables 2 and 3).

Flock composition

During the months when Carnaby's numbers were on the increase, the composition of flocks at Hollywood comprised approximately 60% pairs and 40% triplets (pair and fledged young that was still being fed). Thereafter, as numbers progressively decreased, there was a gradual progressive trend for pairs to increase to just over 70% and triplets to decrease to just under 30% of flocks (Fig. 3 and Table 4).

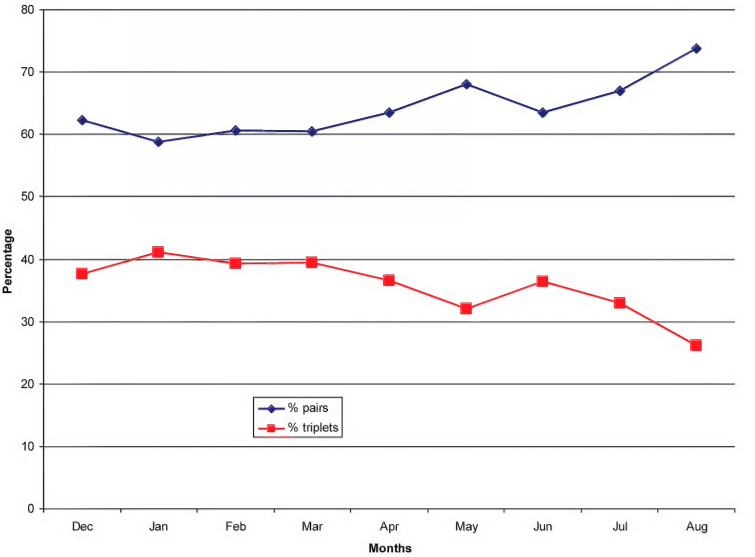

Figure 3. Monthly proportions of pairs and triplets (pair and fledged juvenile) recorded at the Hollywood roosting site between April 2006 – August 2017 (data from months of Sept., Oct. and Nov. excluded because of comparatively smaller sample sizes). (See Table 4.)

Table 2. Roost counts of Carnaby's Cockatoos at overnight roosting sites at Perry Lakes (February 2007–August 2017. (Numbers in brackets = days counted Bold typeface = maximum numbers in each year).

MONTHS	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
PERRY LAKES MEAN												
2007/08						10	53	134	**260**	213	141	75
2008/09	0	0	0	4	7	21	93	109	**168**	167	149	92
2009/10	17	0	0	0	20	14	37	202	**270**	222	160	32
2010/11	7	0	0	2	9	22	188	**221**	212	198	148	4.1
2011/12	0	0	3	31	26	33	103	207	204	**228**	135	26
2012/13	5	0	7	6	22	25	116	145	**242**	203	136	96
2013/14	25	0	27	10	5	69	97	**241**	224	162	94	9
2014/15	0	0	0	22	12	41	209	**283**	261	190	55	34
2015/16	1	0	0	6	32	49	151	**268**	259	162	137	22
2016/17	5	–	0	25	52	92	260	293	293	**302**	240	52
Mean	7	0	4	12	20	38	131	210	239	205	139	44
Median	5	0	4	6	20	29	109	214	250	201	139	33
Max.	25	0	27	31	52	92	260	293	293	302	240	96
Min.	0	0	0	0	5	10	37	109	168	162	55	4
PERRY LAKES MAXIMUM												
2007/08						19 (6)	108 (10)	**263** (8)	173 (8)	165 (7)	191 (12)	190 (6)
2008/09	0	0	0 (2)	14 (4)	44 (6)	70 (4)	230 (12)	192 (13)	**272** (15)	225 (13)	211 (8)	218 (9)
2009/10	6 (12)	0 (3)	0	0	97 (6)	107 (16)	140 (19)	**444** (16)	382 (21)	325 (21)	212 (17)	91 (19)
2010/11	20 (12)	0 (2)	0	16(4)	52(20)	113(16)	318 (17)	**353** (13)	328 (18)	283 (12)	221 (11)	122 (19)
2011/12	0 (0)	0 (0)	8 (3)	80 (9)	126 (21)	184 (18)	209 (18)	318 (19)	**350** (22)	296 (14)	230 (21)	66 (20)
2012/13	17 (12)	0	26 (15)	20 (15)	168 (25)	145 (17)	**251 (20)**	218 (8)	351 (19)	215 (5)	237 (15)	168 (16)
2013/14	13)	– (0)	40 (6)	34 (8)	35 (13)	156 (16)	194 (18)	**408** (11)	307 (18)	254 (19)	202 (19)	42 (6)
2014/15	– (0)	– (0)	– (0)	51 (5)	35 (14)	189 (12)	384 (15)	**445** (18)	318 (5)	300 (15)	91 (11)	55 (3)
2015/16	2 (3)	– (0)	8 (3)	33 (6)	159 (8)	91 (4)	280 (20)	**414** (13)	338 (10)	260 (12)	245 (12)	35 (7)
2016/17	14 (3)	– (0)	0 (1)	153 (12)	231 (17)	351 (11)	388 (18)	**421** (16)	399 (10)	395 (13)	152 (9)	250 (18)

Table 3. Combined counts of Carnaby's Cockatoos at overnight roosting sites at Hollywood and Perry Lakes (February 2007–August 2017. (Numbers in brackets = days counted. Bold typeface = maximum numbers in each year).

MONTHS	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
HOLLYWOOD + P. LAKES MEAN												
2007/08					70	179	**292**	272	**292**	253	194	81
2008/09	0	0	19	24	140	153	240	**352**	288	234	195	211
2009/10	112	38	2	27	70	208	227	**368**	348	243	179	32
2010/11	7	0	0	109	127	144	280	263	**317**	298	220	46
2011/12	0	0	3	22	74	132	226	415	**447**	378	142	21
2012/13	5	0	7	14	104	145	**389**	290	325	166	119	142
2013/14	18	0	27	12	51	153	204	**400**	376	226	94	15
2014/15	6	0	1	37	45	90	426	**455**	273	329	46	34
2015/16	1	0	3	36	89	169	282	**441**	392	306	132	19
2016/17	7	0	0	25	91	198	412	**435**	382	415	382	200
Mean	7	0	4	12	20	38	131	210	239	205	139	44
Median	5	0	4	6	20	29	109	214	250	201	139	33
Max.	25	0	27	31	52	92	260	293	293	302	240	96
Min.	0	0	0	0	5	10	37	109	168	162	55	4
HOLLYWOOD + P. LAKES MAXIMUM												
2007/08						331 (3)	392 (7)	394 (8)	**405** (8)	284 (7)	269 (12)	200 (5)
2008/09	0 (3)	0 (2)	34 (2)	69 4)	254 (6)	368 (4)	473 (8)	506 (11)	486 (15)	**510** (13)	235 (8)	299 (9)
2009/10	199 (10)	131 (2)	11 (26)	87 (28)	144 (6)	301 (15)	545 (17)	**550** (16)	518 (21)	407 (21)	232 (17)	91 (19)
2010/11	20 (12)	0 (2)	0 (0)	167(4)	284(20)	291(16)	420 (17)	353 (13)	**504** (18)	431 (12)	340 (7)	122 (19)
2011/12	– (0)	– (0)	8 (3)	23 (2)	176 (20)	278 (15)	371 (15)	558 (11)	**590** (11)	494 (12)	66 (14)	0 (4)
2012/13	17 (13)	– (0)	26 (21)	44 (16)	203 (18)	234 (14)	**640** (19)	350 (6)	565 (19)	323 (20)	304 (7)	250 (13)
2013/14	47 (9)	0 (30)	40 (6)	34 (8)	171 (11)	237 (13)	305 (14)	**614** (8)	566 (7)	299 (14)	202 (19)	42 (9)
2014/15	53 (5)	– (0)	8 (6)	72 (4)	169 (18)	315 (23)	587 (8)	629 (8)	**651** (7)	515 (9)	91 (10)	55 (6)
2015/16	2 (3)	– (0)	8 (3)	64 (5)	273 (6)	226 (2)	585 (14)	**677** (12)	555 (5)	440 (7)	243 (8)	21 (4)
2016/17	14 (2)	– (0)	0 (1)	50 (2)	160 (9)	323 (12)	532 (6)	523 (4)	**574** (15)	468 (4)	529 (6)	277 (8)

Table 4. Monthly percentage of pairs and triplets (pair and fledged juvenile) recorded at the Hollywood roosting site between April 2006 – August 2017 (data from months of Sept., Oct. and Nov. excluded because of comparatively smaller sample sizes).

Months	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
% pairs	62.3	58.9	60.7	60.5	63.5	68.0	63.5	67.0	73.8
% triplets	37.7	41.1	39.3	39.5	36.5	32.0	36.5	33.0	26.2
# of pairs & triplets counted	342	1978	3159	3692	2773	4385	2922	688	662

DISCUSSION

The records during all years counted to date confirm the clear seasonal trend of abundance of Carnaby's Cockatoo in the Western Suburbs and that the Hollywood roosting site is occupied earlier in the season than the one at Perry Lakes. The only variation from this trend of seasonal abundance was in 2009/10, 2012/13 and 2016/17 when their departure was later than in other years. It is noteworthy that these three years correspond with years of masting of Norfolk Island pines (*Araucaria heterophylla*). The large and abundant seeds accumulate at the bases of these trees and provide a significant long-lasting food source for Carnaby's Cockatoos (Berry and Owen 2009). This may account for a delay in departure, particularly of non-breeding birds.

The slight increasing trend in cockatoo abundance in the Western Suburbs suggested by mean monthly modal numbers does not necessarily indicate an increase in the Carnaby's population as a whole. Indeed, it may be a consequence of progressive clearing of the pine plantations at Gnangara and displacement of some birds from this sub-population to the Western Suburbs. We have previously stated that the consistency of numbers of Carnaby's Cockatoos recorded in the Western Suburbs sub-population suggests that there is a correlation between number of birds and food resources available to support them (Berry and Owen 2009). Clearing of native bushland in the Western Suburbs continues to be the major potential threat to Carnaby's Cockatoo. However, it appears that these adaptable birds have so far been able to substitute exotics as well as natives planted in gardens and on road verges as a food source. (The planting of food trees on road verges particularly along median strips, and the railway reserve, has had an inadvertent negative impact because of the vehicle and train strikes on cockatoos that result).

Another factor that could potentially impact negatively on food availability for Carnaby's Cockatoo is the arrival in the Western Suburbs and rapid increase in numbers over the last five years of Forest Red-tailed Black Cockatoos (FRTBC) (*Calyptorhynchus banksii naso*). There are now frequently more FRTBC than Carnaby's roosting in the Western Suburbs (they roost at separate sites) and there is some limited overlap in food resources between the two. FRTBC are much more restricted in their food sources than Carnaby's (Johnstone *et al.* 2011, Johnstone *et al.* 2017) and they appear to be principally sustained by Cape Lilac (*Melia azedarach*) which is not a favoured food of Carnaby's. However, both species feed extensively on Marri (*Corymbia calophylla*) as well as Jarrah (*Eucalyptus marginata*), *Banksia* spp. and *Hakea* spp. which are all diminishing in abundance with clearance of native bushland.

The Australian White Ibis is another recent arrival as a garden bird in the Western Suburbs. In 2017 it was first noticed that they are attracted to roost in trees already occupied by roosting Carnaby's Cockatoos. However, the cockatoos are completely intolerant of the ibises and the whole flock immediately leaves a roost tree if even a single ibis arrives. Disruption to roosting Carnaby's is now regularly caused by ibises at the Hollywood site.

Carnaby's Cockatoo was first recorded to roost regularly at sites in Hollywood in 1981 (Berry 2008) and the data presented here demonstrate that a stable, or possibly even slightly increasing sub-population has continued to successfully forage and roost in the Western Suburbs during the non-breeding season. Whether this iconic cockatoo will continue to thrive in the face of continued loss of native bushland and recently proposed "infill" in the Western Suburbs which would greatly increase housing density and traffic, while reducing tree cover significantly is yet to be seen.

ACKNOWLEDGEMENTS

We thank Ian Abbott and Ron Johnstone for their comments on the manuscript.

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URSINIA NANA DC (ASTERACEAE) IS NATURALISED IN WESTERN AUSTRALIA

By GREG KEIGHERY[1] and BRONWEN KEIGHERY[2]

[1]Keiran McNamara Conservation Science Centre, Department Biodiversity, Conservation & Attractions, Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983

[2]Agonis Botanical Consultants, 224 Hamersley Road, Subiaco, Western Australia. 6008

greg.keighery@dbca.wa.gov.au

ABSTRACT

Ursinia nana (Asteraceae) is confirmed as naturalised in Western Australia.

INTRODUCTION

Ursinia is a moderate sized genus of Asteraceae of 39 species, 38 of which are confined to South Africa. There are two species (*U. anthemoides* (L.) Poir. and *U. speciosa* DC.) naturalised in Australia and Western Australia (Florabase 1998, Keighery and Longman 2004).

Prassler (1967) also listed a third species, *Ursinia nana* DC. naturalised for Australia. This listing was based on a specimen collected by Meebold from Karrakatta in 1933 (Specimen in Munich). Thompson (2015) in his treatment of *Ursinia* for the Flora of Australia noted that this was the only record and that there are no recent records from Australia. Therefore, he listed the species as an excluded name. It being assumed that the species was never, or is not now, naturalised in Australia.

This is now the normal assumption, that after 50 years of no records such previously listed naturalised species are regarded as presumed extirpated or presumed never naturalised and removed from listing (Keighery and Parker 2018).

RESULTS & DISCUSSION

Recently during collecting trips to the Western Wheatbelt we collected an unusual *Ursinia* occurring with the common *U. anthemoides*, along a burnt drainage line in Paperbark Nature Reserve (SE of Corrigin, Voucher; Keighery & Keighery 2602). Subsequently, we also collected the same species along a firebreak and in heath in Kulin Road

Figure 1. Flowering heads of *Ursinia anthemoides* (LHS) and *Ursinia nana* (RHS)

Figure 2. *Ursinia nana* with fruits, showing bright white calyx lobes

Nature Reserve (Voucher; Keighery & Keighery 2615) some 35 kilometres south east of the first record.

The collections key to and are a good match for *Ursinia nana* subsp. *nana* (Figures 1 and 2). The presence of this species in several separated reserves suggests it is well established in the area. The lack of recent collections is a little puzzling, including during the recent biological survey of the Wheatbelt (Gibson *et al.* 2004) but the species is superficially similar to the very widespread *U. anthemoides*.

Although *Ursinia anthemoides* was reported by Thompson (2015) as largely confined to disturbed sites, it has proven highly invasive on the Swan Coastal Plain. Keighery (1999) found this species in 40 of 76 reserves surveyed and Gibson *et al.* (1995) found this to be the second most common weed of good quality bushland after the other wind dispersed annual Composite, *Hypochaeris glabra*. Although invasive it is unlikely that either of these small annual species have more than localised effects on native plant communities. Given that *Ursinia nana* is also wind dispersed (Figure 2), we should see many more records over time.

Ursinia nana despite not being recorded in Western Australia between 1933 and 2017 is obviously well established and should be "added to the naturalised flora of Australia.

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INTRA AND INTERSPECIFIC INTERACTIONS INVOLVING *MEROGLOSSA RUBRICATA* AT BEE BLOCKS IN URBANISED SOUTH-WESTERN AUSTRALIA

By KIT (AMY) PRENDERGAST

Department of Environment & Agriculture, Curtin University, Building 311, Brand Drive Bentley, WA, 6102

(Email: kitprendergast21@gmail.com)

ABSTRACT

Behaviours of the Western Australian endemic bee, *Meroglossa rubricata* Smith 1879 (Colletidae: Hylaeinae) at bee blocks in the urbanised region of southwest Western Australia are documented. Observations of co-habitation between individuals are described, and antagonistic interactions between a female *M. rubricata* with a female megachilid at bee blocks is documented. In addition to increasing knowledge about the natural history and behaviour of *M. rubricata*, this paper indicates the value of artificial nesting blocks, not only for the potential to provide nesting substrate for native bees, but also for providing opportunities to observe nesting behaviours of cavity-nesting bees.

INTRODUCTION

Artificial nesting blocks, known in the literature as trap-nests, or among the general public as bee hotels, bee blocks or bee condos are recognised as having utility in boosting populations of cavity-nesting Hymenoptera; for monitoring these taxa; and for engaging the public in native bee activities (MacIvor 2016, Dainese *et al.*, Krombein 1967, Tscharntke *et al.* 1998). Monitoring them can provide insights into the nesting behaviour of native bees, interactions between native bees, their fitness in relation to various local and landscape variables, and their nesting and developmental biology. Here, I describe behaviour of the cavity-nesting native hylaeine bee *Meroglossa rubricata* (Smith 1879) which were utilising bee blocks installed around Perth, urbanised south-west Western Australia.

Meroglossa rubricata (Smith, 1879) is a strikingly-coloured native bee in the family Colletidae, subfamily Hylaeinae, endemic to the western areas of the Australian continent. Like the majority of hylaeine bees, *Meroglossa rubricata* is a cavity-nesting species

(Houston 1981). Interspecific interactions at a common nest site are seldom observed. Observations are provided on agonistic behaviour of *Meroglossa rubricata*, towards a megachilid utilising a common bee block.

METHODS

Observations occurred whilst conducting native bee surveys at seven bushland sites and seven residential garden sites around Perth, within the urbanised region of southwest WA. Monthly surveys were undertaken in 50 x 50 m quadrats, from October to March, and involved random-walk sweep netting from 9:30am – 2:30pm, complemented by passive sampling using UV-reflective blue and yellow "bee bowls" placed on bamboo stakes approx. 15cm above ground level in open areas (LeBuhn *et al.* 2003), as well as four vane traps (2 yellow, 2 blue) hung from tree branches at approx. 1m heights) (Stephen and Rao 2005). Eight bee blocks were also installed on tree branches at about 1.5m height. These comprised blocks of untreated Jarrah (*Eucalyptus marginata*) of dimensions 200mm x 100mm x 100mm. Inserted into holes drilled in each block were 15 cardboard bee tubes (Custom Paper Tubes Inc., Cleveland, USA), 12cm long, five each of 4mm, 7mm and 10mm in diameter. During monthly surveys at each site, completed tubes (evidenced by being capped with materials characteristic for a given bee taxon) were removed and replaced with new tubes. The completed tubes were placed in individual perforated plastic take-away containers in the lab to develop at room temperature, and monitored every few days to record bee emergences.

NATURAL HISTORY OBSERVATIONS AND DISCUSSION

Both male and female *Meroglossa rubricata* were observed and collected by sweep-netting (Figs 1–7), albeit at low abundances during my native bee surveys, and this species also utilised trap-nests. Of interest was finding more than one *Meroglossa rubricata* individual inhabiting the same tube, given that this species is usually considered to be a solitary bee. At a residential garden site in Wembley, located in urbanised Perth, a 4mm-diameter tube collected on 18 February 2017 contained two adults, one male and one female. The tube was completely empty of cells, provisions and lining and was closed at the open end by cellophane-like secretion. This indicates that the male and female had not emerged inside that tube, but were sheltering there temporarily, perhaps from heavy, atypical rain which occurred at the time. Adults in bee tubes not stocked with provisions were also collected from Maniana Reserve in Queens Park, but only singly, and all were females.

Most colletids are solitary, and whilst nest aggregations are common, communal nesting or even primitive levels of sociality are extremely rare (Almeida 2008). My observations of *M. rubricata* are in accordance with those of Michener (1960) on nesting behaviour of two related species, *Meroglossa sculptifrons* (now *Amphylaeus (Amphylaeus) morosus*) (Smith 1979), and *M. torrida* (Smith 1979) suggesting that these species show plasticity in their gregariousness. Michener (1960) also reported instances of both single females utilising nests, as well as multiple individuals, both male and female, co-existing in a nest for some time, but no evidence of cooperative nesting was found.

Two other 4mm tubes were collected from Wembley during the February survey, both with the characteristic cellophane-like cap produced by colletids such as *M. rubricata*. From one of these tubes, one *M. rubricata* female emerged on 1 March 2017; it is likely the other tube also was nested in by *M. rubricata*, the progeny of which either have suffered mortality or are diapausing to emerge in spring. The only other site in which *M. rubricata* have emerged from collected bee tubes is Osborne Park – another residential site in the heart of Perth suburbia. The 4mm tube was collected on 11 Dec 2016, and on 12 Dec 2016 a female emerged. It is likely that this was the mother, for no other bees emerged until 16 Jan 2017, when four individuals were found.

At Osborne Park, during surveys females were collected foraging on *Callistemon viminalis* (Fig. 1) and *Corymbia ficifolia* (Myrtaceae). In contrast, foraging *M. rubricata* were never observed during my surveys at the Wembley site. This may suggest that resources in the residential garden surveyed were unsuitable and that the bees were foraging elsewhere. My observations therefore indicate the importance of providing nesting habitat for cavity-nesting bees, especially in the suburbs, and underscore how bees recognise "partial landscapes", whereby as central place foragers, they may nest and forage in different habitat patches (Westrich 1996).

M. rubricata has also been observed foraging at three other sites out of the fourteen surveyed: Maniana Reserve (a bushland site in Queens Park), and two residential sites: Jandakot (located in the outer peri-urban area, observed foraging on *Eucalyptus erythrocorys*), and Wilson (located in suburbia, but adjacent to Canning Reserve, found foraging on *Corymbia calophylla* that line the verges). At Jandakot, nesting behaviour was also observed during the January survey (28 Jan 2017). Here, a female *Meroglossa rubricata* was utilising one of the bee blocks that was also being used by megachilids. Both the *Meroglossa* and megachilids were actively provisioning nest tubes. The *Meroglossa* displayed antag-

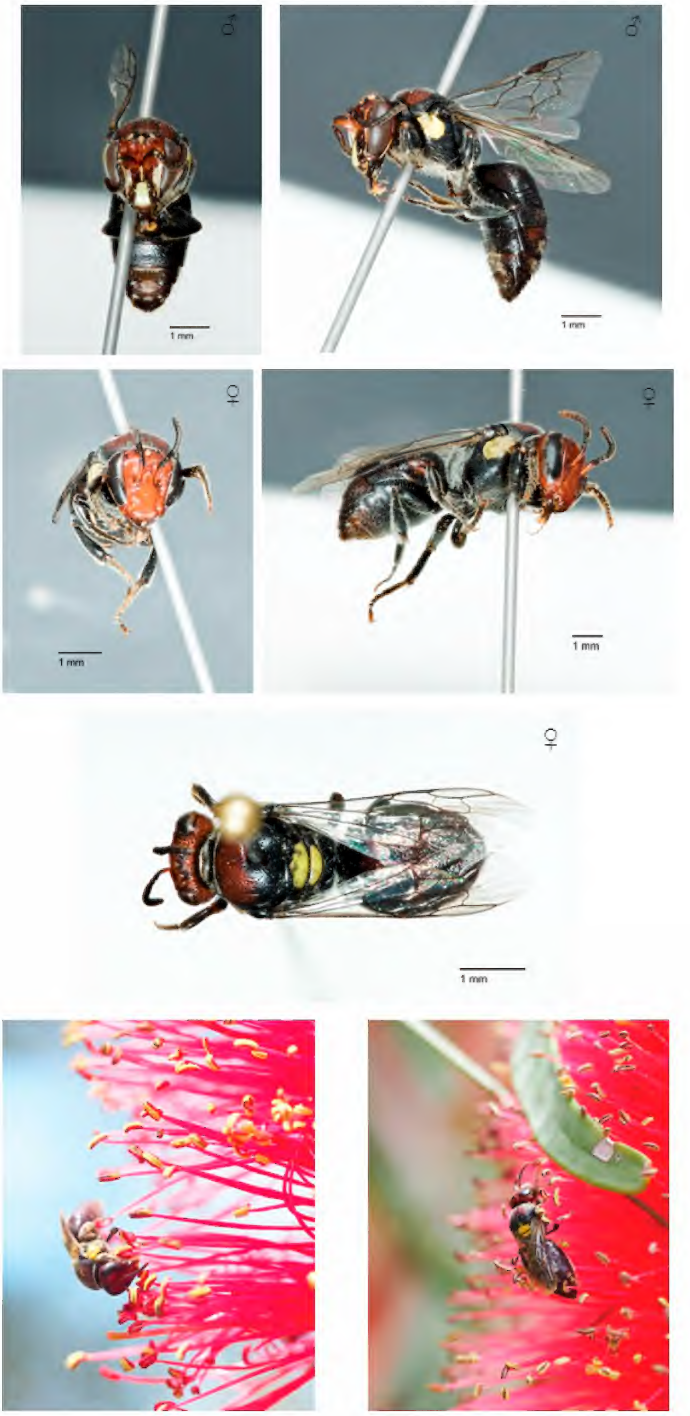

Figure 1. *Meroglossa rubricata.* Male, top row, female, second and third row, female foraging on *Callistemon viminalis,* bottom row.

onistic behaviour, emerging from her nest hole and head-butting the megachilid in the nest tube adjacent! She did this a number of times, but the megachilid, with her rear facing outward, did not budge and was not deterred by the *Meroglossa*'s head-butting of her rear (Fig. 2).

During the survey the following month in February, tubes with cellophane-like material around the tube entrances were observed, but the caps had been broken, leaving the tubes open, suggesting that in the interim between my surveys the bees had completed development and emerged.

Completed tubes likely containing developing *Meroglossa rubricata* have been collected from Maniana Reserve, Queens Park, but no bees have emerged. It may be that the larvae, pupae or adults are diapausing over autumn and winter (Michener 1960), to emerge in spring, coinciding with warmer temperatures and the flush of resources that characterise this Mediterranean environment (Lambers 2014), or alternatively, that for various reasons the eggs failed to develop or the offspring contained have died from various mortality factors (fungal or bacterial pathogens, parasites, insufficient or inadequate provisions, adverse temperatures or humidity etc.).

The use of only the 4mm tubes by *Meroglossa rubricata* indicates a clear preference for this tube diameter, and is in accordance with the diameters used by *Meroglossa* species in natural nesting materials (Michener 1960).

To promote the reproductive success of this endemic native bee, *Meroglossa rubricata*, my observations show that providing bee blocks with 4mm diameter holes is optimal, and that *Corymbia calophylla*, *Callistemon viminalis* and *Eucalyptus erythrocorys* – all common native Australian trees throughout Perth suburbia – should be retained and actively planted on road verges and other "greenspaces" to provide foraging resources.

These observations should stimulate further hypotheses regarding nesting competition, especially at bee blocks which are increasingly being installed for both scientific monitoring purposes, as well as a citizen scientist initiative for urban citizens to engage in promoting native bees. It will be interesting to see if such territorial interactions occur between *Meroglossa rubricata* and other cavity-nesting bees in "natural cavities", or whether such behaviour is encouraged when providing artificial cavities in the form of bee blocks.

ACKNOWLEDGEMENTS

I would like to express my appreciation to the residents for permitting me to survey their properties for native bees, to the

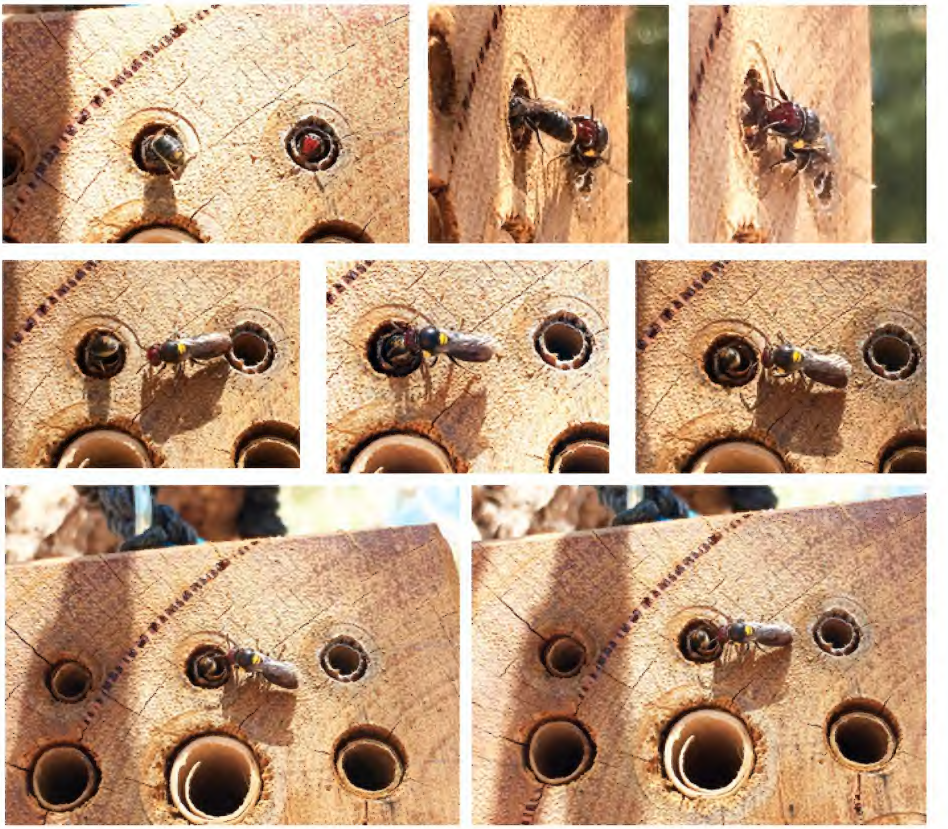

Figure 2. Female *Meroglossa rubricata* head-butting the behind of a native megachilid bee in an adjacent bee tube within a bee block located at Jandakot, WA.

WA Museum for permitting me to use their photographic microscope, to Dr Bill Bateman for his support, encouragement, and helpful feedback, and Mark Donald – "King of Drones" – for inspiring the author.

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BASKING BEHAVIOUR IN TIGER SNAKES, *NOTECHIS SCUTATUS* (ELAPIDAE) AT HERDSMAN LAKE, WESTERN AUSTRALIA

By PAUL ORANGE
18 Balfern Court, Hamersley, WA 6022

INTRODUCTION

I have been observing and photographing Tiger Snakes, *Notechis scutatus* at Herdsman Lake (31°55'44"S, 115°48'19"E) in metropolitan Perth for over thirteen years. I try to photograph Tiger Snakes *in situ* without disturbing them, to obtain as natural a photograph as possible and to minimise stress to the animal. Fortunately this unobtrusive approach has resulted in observations of their behaviour that might otherwise have gone unnoticed (e.g. Orange 2007). Basking Tiger Snakes, neatly coiled in sunlight, are an obvious subject and much of my time is spent attempting to photograph these. As a consequence, certain aspects of their basking behaviour have become evident that seemingly put them at risk of increased predation.

OBSERVATIONS

Tiger Snakes at Herdsman Lake can often be seen basking in exposed situations, either directly on the substrate (soil, leaf litter) or atop flattened vegetation, especially grass tussocks. Basking behaviour is more obvious during the cooler months (April to November inclusive), especially in autumn (April, May) and late winter–spring (August to October).

Attempts to photograph basking Tiger Snakes involve slowly and discreetly approaching a snake to within an appropriate distance (depending on the type of lens being used) without disturbing it and causing it to flee. Snakes that have recently emerged to bask may be quite cold and disinclined to move, thereby allowing a closer approach. Such snakes usually adopt a tightly coiled, often circular posture (Figure 1). As their body temperature increases they loosen their coils and their posture tends to become more elongated (Figure 2). Tiger Snakes in this position are generally more alert and can be difficult to approach. Occasionally Tiger Snakes can be seen basking with their body completely extended and flattened, tilted towards the sun (Figure 3). This posture seems to be adopted later in the day when a snake is 're-warming' itself and a close approach is rarely tolerated.

On a number of occasions I have encountered Tiger Snakes

Figure 1. Tiger Snakes that have recently emerged to bask usually adopt a closely coiled, often circular posture.

Figure 2. As their body temperature increases they loosen their coils and their posture tends to become more elongated.

Figure 3. A Tiger Snake basking with its body completely extended and flattened, tilted towards the sun.

Figure 4. Tiger Snake basking with its head placed between its coils, thus obscuring its vision.

Figure 5. Tiger Snake basking with its head amongst grass beneath a piece of bark.

basking with their head between their coils (Figure 4) or amongst grass (Figure 5), which obscures their vision. That I was able to approach these snakes very closely (on occasion to *c.* 1 m) without disturbing them indicates they were unable see me. In some instances I was able to approach a snake, take a number of photographs, and retreat without it responding to me.

On 29 October 2017 I observed a Tiger Snake basking in an open area, lying atop dead grass. Whilst photographing it (using a 100 mm macro lens) a small black ant wandered onto the snake's body,

Figure 6. Tiger Snake seen basking on 29 October 2017 with its head between its coils. It was still in this position an hour later.

where it hurried aimlessly for a number of seconds. This appeared to irritate the snake, causing it to move its coils around and then tuck its head between them. It maintained this position after the ant had gone and I was able to approach close enough (*c.* 1 m) to photograph it using the camera on my mobile phone (Figure 6). From such a short distance I could verify that its eyes were indeed covered and presumably it could not see me. Shortly afterwards I left the area, but upon returning an hour later I found the snake to be still in the same position, head in coils, vision obscured. It was still in this position when I left.

I have also encountered Tiger Snakes sleeping whilst basking. Judging a snake, which lacks eyelids, to be asleep can be problematic. However, sleeping snakes seem more relaxed: their body coils have a slightly flattened, sunken appearance and their head likewise. Such snakes sometimes wake with a definite 'start', thereby confirming that they were asleep.

DISCUSSION

Tiger Snakes at Herdsman Lake inhabit what has been described as a "predator-rich" environment by Aubret *et al.* (2011), who recorded eight predator groups: Cat (*Felis catus*), Fox (*Vulpes vulpes*), Dog (*Canis domesticus*), Kookaburra (*Dacelo novaeguineae*), Swamp Harrier (*Circus approximans*), eagles (spp.), falcons (spp.) and humans (*Homo sapiens*). As a result, adult Tiger Snakes are notably vigorous in their defensive behaviour (Bonnet *et al.* 2005; Aubret *et al.* 2011). Therefore my observations that some Tiger Snakes should expose themselves to possible predation by basking in open situations with their eyes covered or asleep, i.e. effectively blind, seems counterintuitive.

Nor is such behaviour restricted to basking. In an earlier paper (Orange 2007) I recorded Tiger Snakes at Herdsman Lake burrowing their heads several centimeters into damp, loose soil and leaf litter in search of frogs. In doing so they would sometimes spend many minutes with their head and eyes covered and their body exposed. This 'fossorial foraging' behaviour is not uncommon and several Tiger Snakes have been seen on subsequent occasions searching leaf litter and dry, loose soil (also M. Orange & G. McDade pers. comm.), presumably for the small skinks that occur there.

Tiger Snakes typically rely on vision to detect predators (Bonnet *et al.* 1999; pers. obs.). That they should restrict their vision for extended periods then is remarkable. Admittedly, the total number of Tiger Snakes I have seen basking with their heads covered is small (*c.* 7), and those sleeping difficult to judge, but likely few. However, when combined with the widespread behaviour of fossorial foraging, the number of Tiger Snakes that habitually impede their vision must be substantial.

It may be significant that all Tiger Snakes I have observed in these circumstances have been adults. Small (juvenile) Tiger Snakes are at greater risk of predation (Aubret *et al.* 2007) and therefore unlikely to behave in such a manner. Adult Tiger Snakes are large and highly venomous and this may discourage some predators, thereby reducing the risk of predation.

'Blind' basking behaviour may be more common than currently recognised, having gone unnoticed due to the nature of interactions with Tiger Snakes. Much of the research published in the scientific literature is experimental and involves disturbing (capturing) the snakes. Whereas, my deliberately unobtrusive approach increases the likelihood of their natural behaviour being observed.

It would be useful to ascertain if the basking behaviour described by me occurs in other Tiger Snake populations and, if so, to compare predator-rich environments with predator-poor environments. Would this be-

haviour occur more frequently in predator-poor (low predation risk) rather than predator-rich (high predation risk) environments?

ACKNOWLEDGEMENTS

My thanks go to Mark Orange and Gordon McDade for sharing their observations with me, and to Nicole David and Miles Orange for their tolerance of my ophidian obsession. I am also grateful to John Dell for his comments and suggestions on an earlier draft of this paper.

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SWAN COASTAL PLAIN STUDIES: TAXONOMIC NOTES ON *BOSSIAEA ERIOCARPA* BENTH. AND *BOSSIAEA ORNATA* (LINDL.) BENTH. (BOSSIAEEAE: FABACEAE)

By GREG KEIGHERY

Science Division, Department of Biodiversity, Conservation and Attractions, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983.

Email: bjkeighe@it.net.au

ABSTRACT

A new combination in *Bossiaea* is made for *Bossiaea angustifolia*, to formalise the collections segregated as *Bossiaea* sp. Waroona (BJ Keighery & N Gibson 229) in PERTH. A previously synonymised species, *Bossiaea lalagoides* F.Muell. is segregated from *Bossiaea ornata* to replace the phrase name *Bossiaea* sp. Bremer (K. Newbey 2980). A new species, *Bossiaea moylei* Keighery is described, confined to a range of Chert hills north of Moora. This replaces the phrase name *Bossiaea* sp. Cairn Hill (M. Henson 2–28).

INTRODUCTION

Detailed field studies on the Swan Coastal Plain over the past 30 years (e.g. Gibson *et al.* 1994), has uncovered many taxonomic issues in the local flora. This paper formalises the naming of a series of species of conservation significance in the genus *Bossiaea* and in doing so reduces the confusion between the very common species *Bossiaea eriocarpa* and *B. ornata*.

Bossiaea eriocarpa is the most widespread and variable of the genus in southern Western Australia (Ross 2006). The limits of this species and the related *Bossiaea ornata* have been the source of confusion for many years. For example, both the Flora of the Perth Region (Marchant *et al.* 1987) and the Flora of the South West (Wheeler *et al.* 2002) noted that *B. eriocarpa*: was a very variable species; and was especialy similar to a narrow leaved variant of *B. ornata* that approached *B. eriocarpa* and could be a hybrid between the species. As a consequence the *Bossiaea eriocarpa* Benth. / *B. ornata* (Lindl.) Benth. complex has proved difficult taxonomically for many years.

The taxonomic complexity of the *Bossiaea ornata/eriocarpa* group may match members of the orchid genus *Diuris* (especially the *Diuris corymbosa* complex) that are considered to

be floral mimics of *Bossiaea* in Western Australia (Brundrett 2014 and Adams & Lawson 1993). Unravelling the *Bossiaea ornata/B .eriocarpa* complex may assist with understanding this complex.

Bossiaea ornata complex

Detailed field studies have shown that hybridisation has not been verified between *Bossiaea eriocarpa* and *B. ornata*, and the problem has been a third species, which overlaps in some character states between the species. Ross (2006) retained this variant under *B. ornata* in his revision. Collections of this taxon are now segregated at PERTH under the phrase name, *Bossiaea* sp. Waroona (BJ Keighery & N Gibson 229) and are re-instated as a distinct species in this paper.

Bossiaea sp. Waroona co-occurs with *B. eriocarpa* at Bandicoot Nature Reserve, north of Waroona and no signs of hybridisation or integration were observed (collections B. J. Keighery & N. Gibson 886 and B. J. Keighery & N. Gibson 1073, PERTH). Both species also co-occur at Biodhinya Monastery, east of Serpentine (collections B. Nyananatusita 215 & 215A, PERTH). Similarly this taxon co-occurs with *B. ornata* in the Whicher Range and no intermediates are found (Keighery *et al.* 2008). Other detailed survey has shown that the two species are readily distinguishable and never intergrade, even when co-occurring (Gibson *et al.* 1994, Keighery *et al.* 2007 and 2008).

Clearly this is a separate species and examination of type material of the genus *Bossiaea* showed that this form has a pre-existing name in the genus *Lalage*, which has been combined with *Bossiaea* and that a new combination is required in the genus *Bossiaea*.

Bossiaea angustifolia (Meisn.) Keighery *comb. nov.* based on *Lalage angustifolia* Meisn., in Lehmann, J.G.C. (1844) Plantae Preissiana 1(1): 86, adnot.

Type: "Swan River, James Drummond n. 253.: lecto.: K(!), isolecto.: MEL 105912 (!). Leaves of three species shown in Figure 1.

Selected specimens examined (53 seen, all PERTH). WESTERN AUSTRALIA: 21 km. N.W. of Wundowie, 15 Sep. 1998, *G.J. Keighery & N. Gibson* 5961 (PERTH); Helena Valley, 8 Oct. 1996, *A. Markey* 1105 (PERTH); Waterloo, 11Sep. 1994, *G.J. Keighery* 13465 (PERTH); Ironstone Gully, Donnybrook to Capel, 19 Oct. 1995, *B.J. Keighery* 2410 (PERTH).

Distribution and habitat. Recorded from the Jarrah Forest and Swan Coastal Plain Bioregions, from near Gingin east to Wundowie and south to Abba Forest Block, south west of Busselton. This species is particularly common along the Darling Escarpment.
Occurs on sands, lateritic sands, sandy clays and clays in woodlands of Jarrah/ Marri, Wandoo, Powder Bark Wandoo,

Marri, Mountain Marri and combinations of these.

Flowering period. Flowering in spring, from August to October. Mature fruits and seeds are found in November.

Conservation status. Although more localised than other members of the complex this species is widespread in State Forest and Darling Range Regional Park and is relatively well conserved.

Etymology. From the narrow leaves (compared to *Bossiaea ornata*).

Notes. The form distinguished as *Bossiaea angustifolia* differs from both *B. ornata* and *B. eriocarpa* in being a tall slender few branched single stemmed shrub to 1.5 metres tall, lacking a lignotuber compared to overlapping populations of *B. eriocarpa* and *B. ornata*. *Bossiaea angustifolia* has long narrow lanceolate leaves (40–70 mm long x 11–17 mm wide) compared to: the ovate leaves of *B. ornata* (21–40 mm wide x 21–33 mm long); and the linear leaves of *B. eriocarpa* (10–22 mm long x 2–4 mm wide). The stipules are also long and broad compared to the other two species (Figure 1). The flowers are larger than those of *B. eriocarpa*, but are comparable to *B. ornata*.

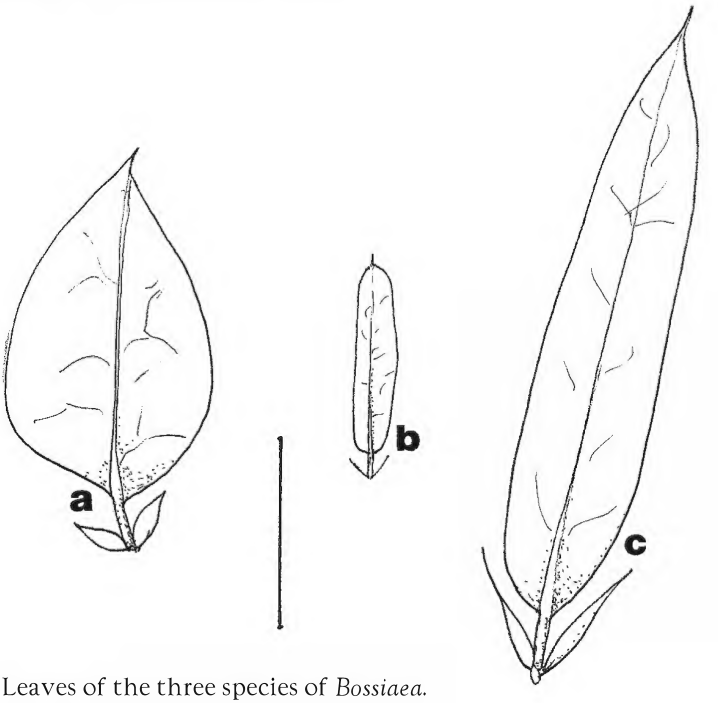

Figure 1. Leaves of the three species of *Bossiaea*.
a: *Bossiaea ornata* (Keighery 7441, PERTH).
b: *Bossiaea eriocarpa* (Keighery 16785, PERTH)
c: *Bossiaea angustifolia* (Keighery 17312, PERTH). Scale bar=20 mm.

With the removal of *B. angustifolia*, *Bossiaea ornata* still contains a very poorly collected and related species, which the author had provisionally segregated as an unnamed species: *Bossiaea* sp. Bremer (KRN Newbey 2980). After viewing *Bossiaea* the type material in Melbourne in 2010 it was apparent that, although the type of *Bossiaea lalagoides* (placed in under *B. ornata* by Ross 2006), is a comparatively poor specimen, it is a close match for material from eastern populations currently segregated in PERTH under the phrase name *Bossiaea* sp. Bremer (K. Newbey 2980). Hence a complete species description is given below based on complete material in PERTH.

Bossiaea lalagoides F. Muell. Fragm. 4:12 (1863)

Type: In praeruptis ad flumen Gardner's River. Maxwell. (MEL 105232; Lectotype!).

Erect or spreading much branched multi-stemmed *shrub* to 30 cm x 30 cm from a woody rootstock. Young flowering *branches* sparsely to moderately hairy with white, simple appressed hairs becoming glabrous and brown after the first year, ending with smooth dark brown bark at base, slender c. 0.5–1 mm wide when leafy, 1–2 mm wide when mature, and leaf scars persistent. *Leaves* alternate, clustered towards the ends of branches, stipules, prominent, brown, linear, adpressed to stem, 4–6 mm long, 1–2 mm wide, margin entire or with scattered hairs. Young leaves densely hairy. Leaves oblong to ovate, very coarsely reticulate on both surfaces, 10–25 mm long, 5–10 mm wide, apex acute with recurved mucrone, c. 0.5 mm long, margins in-rolled, glabrous, dark shiny green. *Flowers* solitary in upper leaf axils subtended by a series of 6–10 overlapping brown *bracts*, *outer bracts* ovate, scarious, with a jagged ciliate margin, c. 2 mm diameter, next ovate to broadly ovate, sparsely pubescent to glabrous, margins ciliate, 3 mm diameter, *inner bracts*, inrolled, linear-obovate, pubescent, 4 mm long. Individual flowers subtended by two linear –triangular sparsely hairy, usually caducous green bracteoles. *Pedicel* slender, reddish-green, glabrous (rarely with sparse hairs), 7–10 mm long. *Calyx* two lipped upper broad, green, total 8 mm long, lobes 6 mm long, upper lobes with ciliate margins (rarely sparsely hairy). *Standard petal* reverse brownish-red, obverse yellow in upper half, eye yellow with brownish-red halo, 8 mm wide, 8 mm long, apex acute. *Wings* dull red, 8 mm long. *Keel* base colourless, then pale red upper third red grading to dark red, 8 mm long, 4 mm wide. *Stamens* 10, c. 10 mm long. *Fruit* sparsely hairy, 15–23 mm long.

Selected specimens examined: S. of Tenterden, Sep. 1902, *A. Morrison* s.n. (PERTH), Bremer River, 7 Sep. 1969, *K. Newbey* 2980 (PERTH), St. Werburgh's Road, Mount Barker,

12 Sep. 1982, *E. Croxford* 1999 (PERTH), One kilometre north of Tenterden, 19 Sep. 2009, *G.J. Keighery* 17558 & *A.H. Burbidge* (PERTH).

Distribution and habitat. Kendenup to the Gardner and Bremer River, growing on winter damp sandy flats dominated by *Eucalyptus staeri* and *Eucalyptus wandoo* woodlands.

Flowering and fruiting time. Recorded in flower between August and September. Mature fruits were found from November to December.

Notes. This species differs from *Bossiaea ornata* in the smaller narrow-ovate-oblong leaves (up to 20 mm wide in *B. ornata*), which are generally glabrous with inrolled margins. The species has slender stems (3–4 mm wide in *B. ornata*). Flowers are solitary compared to paired in *B. ornata* and are on long slender glabrous pedicels which are densely sericeus and scarcely exceeding the leaves in *B. ornata*. The calyx is densely sericeus in *B. ornata* and the flowers are much larger.

Bossiaea lalagoides has a more easterly distribution to *B. ornata*; although the ranges of the two species overlap north and west of Mount Barker, no mixed populations have been located.

Conservation status. No recent collections of the eastern populations (Bremer and Gardner River) have been made. This species is currently not known from any conservation reserve, but is poorly surveyed; it should be listed as Priority 1 (Smith 2016).

Etymology. Lalagoides because of its similarity to the genus *Lalage*, where the closely related *Bossiaea ornata* was originally placed.

Bossiaea ornata with the removal of *Bossiaea angustifolia* and *B. lalagoides* is now a relatively uniform species across its range being a low spreading multi-stemmed shrub with broad leaves and large flowers.

Bossiaea eriocarpa complex

However, *B. eriocarpa* remains a species complex. The species (as presently defined) comprises six taxa.

- Short lived re-seeder in the Jarrah Forest (the true *B. eriocarpa*)
- Short lived re-seeder of the Dandarragan Plateau and Eneabba Sandplains with yellow flowers and soft hairy shoots and densely packed leaves.
- Long lived re-sprouter with brown/yellow flowers of the Jarrah Forest and Swan Coastal Plain.
- Long lived re-sprouter with large reddish flowers on the Swan Coastal Plain and Eneabba Sandplains.
- Slender leaved re-sprouter of the Geraldton Sandplains
- Slender erect re-seeder with densely pubescent young stems of the Chert Hills north of Moora. This species is

segregated as *Bossiaea* sp. Cairn Hill (M. Henson 2–28).

Detailed studies are still underway to map the distribution of these taxa in *Bossiaea eriocarpa*, decide on their appropriate rank and match them to any available names, generally under the genus *Lalage*. This study will be reported on in detail at a later date. The very distinctive and narrow endemic of the Chert Hills, which is conservation listed, is described herein to provide a valid name for this species.

Bossiaea moylei G.J. Keighery sp. nov.

Bossiaea eriocarpa affinis a qua ramuliis juvenibus et pediceliis et calycibus dense pubescentibus, foliis parce pubescentiis, scabrous, floribus axillaribus duosiis, sine lignotuberousus differt.

Typus: Cairn Hill Nature Reserve, 18 September 2008, *G.J. Keighery* 17315 (*Holo*: PERTH, *iso*: to be distributed).

Erect or spreading much branched *shrub* to 30 cm from a single rootstock. Young flowering *branches* densely white pubescent with simple hairs becoming glabrous and brown after the first year, leaf scars persistent, c 1mm wide. *Leaves* alternate, widely spaced (10–15 mm between leaves) and not crowded, stipules, brown, linear-lanceolate, appressed to stem, 3–4 mm long. Young leaves densely hairy. Leaves linear, dark shiny green, upper surface covered in fine cobwebby hairs and single tuberculate hairs below, margins tightly inrolled, under surface covered in long rusty coloured simple hairs, apex mucronate with tip projected below so as to appear bilobed from above, 10–14 mm long x 1.5–2.5 mm wide. *Flowers* paired in upper leaf axils subtended by a series of 6–8 overlapping bracts, *outer bracts* ovate, with a jagged ciliate margin, c. 1 mm diameter, next ovate to broadly ovate, sparsely pubescent to glabrous, margins ciliate, 3 mm diameter, *inner bracts* 3 lipped, inrolled, linear-obovate, pubescent, 4 mm long. Individual flowers subtended by two linear –triangular pubescent usually caducous green bracteoles. *Pedicel* slender, reddish, sparsely hairy, 5–8 mm long. *Calyx* two lipped upper broad, green pubescent, 8 mm long. *Standard petal* reverse brownish-red, obverse yellow in upper half, eye yellow with brownish-red halo, 12 mm wide, 10 mm long, apex acute. *Wings* base dull red, upper third yellow, 10 mm long. *Keel* base colourless, then pale red upper third red grading to dark red, 10 mm long, 4 mm wide. *Stamens* 10, c.10 mm long. *Fruit* sparsely hairy, 15–20 mm long. (Figure 2).

Selected specimens examined. Cairn Hill, 27 Oct. 2000, *S. Hamilton-Brown, B. Hamilton-Brown* & *A. Reaveley* s.n. (PERTH), 15 km north of Moora, 2 Nov. 1974, *D.J.E. Whibley* 4878 (PERTH, AD), 15 km north of Moora, 21 Oct. 2000, *B. Morgan* 50 (PERTH), 15 km north

Figure 2. *Bossiaea moylei* (Moyle, Keighery and Bellman s.n., PERTH).

a: Front view of flower
b: Flower
c: flowering branch
d: Upper surface of leaf
e: Lower surface of leaf
f: enlargement of upper surface of leaf
g: leaf apex
h: Floral Bracts
i: outer floral bract
j: middle floral bract
k: inner floral bract

of Moora, 22 Oct. 2000, *M.E.T. Trudgen* 21225, 221226 & 21227 (PERTH), Cairn Hill, 22 Oct. 2000, *M. Henson* 2–28 (PERTH).

Distribution and habitat. Confined to a low range of Chert Hills north of Moora. Where the species grows on shallow grey silty sands over chert (Moora Proterozoic Group), under tall shrublands of *Regelia megacephala, Kunzea praestans, Melaleuca calyptroides* and *Dryandra sessilis* often with scattered emergent *Allocasuarina huegeliana* or emergent mallees of *Eucalyptus eudesmioides.* This very distinctive floristic community (Griffin 1992) is now listed as a Threatened Ecological Community (Hamilton-Brown 2000).

Flowering and fruiting time. Recorded in flower between August and September. Mature fruits were found from November to December.

Notes. This very distinctive member of the *Bossiaea eriocarpa* complex differs from all others in the densely pubescent white young stems, with widely spaced dark green leaves that do not overlap. The leaves are small, covered in tuberculate hairs on the upper surface and a loose indumentum of rusty hairs below. The pedicels and calyx lobes are also pubescent. Flowers are in pairs in the upper axils, subtended by 6–8 imbricate bracts, compared to solitary with two bracts in other members of the *Bossiaea eriocarpa* group.

Conservation status. This species is confined to a series of low chert hills north of Moora. A portion of these chert hills are being converted into a nature reserve as part of the conditions for mining in the remainder of the range (Hamilton-Brown 2000). This species is currently known from this potential conservation reserve, where it is locally abundant. With such a restricted range it should be listed as Priority 2 (Smith 2016).

Etymology. Appropriately the species is named after Brian Moyle, who has worked tirelessly to increase the understanding and value of the flora, vegetation and landscapes of the inland ranges of Western Australia to the public, government and industry over many years.

DISCUSSION

The short lived re-seeders and long lived re-sprouters in both the *B. ornata* and *B. eriocarpa* groups appear to be related to their complex fire related life histories. A similar mix of re-seeders and re-sprouters is also documented from the shrubs and herbs, *Acacia pulchella, Hovea trisperma* (Keighery, unpub. obs.) and in *Lyginia* (Anarthriaceae: Bell & Pate 1993). There are many other observational records from *Grevillea, Hibbertia* and *Acacia* to suggest that such complex life history strategies may be more widespread in southern Western Australia than currently understood. Groups demonstrating

this variation are taxonomically challenging and the possession of differing fir response traits has been used extensively in the taxonomy of the tree and mallee forms of members of the genera *Banksia* and *Eucalyptus*.

All these genera contain both widespread and very narrow elements. A number of these variants may be of conservation significance, yet remain undocumented and hence un-protected. The elucidation of these complexes, such as the Bossiaea *eriocarpa* group requires substantive further work.

ACKNOWLEDGEMENTS

Field work for this study was funded under Swan Bioplan, an initiative of the Minister for Environment. The author was able to view types of *Bossiaea* in MEL with the assistance of Jim Ross, who had these on loan. His comments also helped improve the paper. This paper forms part of a continuing series on the taxonomic outcomes of biological survey work on the Swan Coastal Plain.

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Communal basking by a Tiger Snake *Notechis scutatus* and a Bobtail *Tiliqua rugosa* – On 18 February 2018 at Herdsman Lake (31°55'44"S, 115°48'19"E) one of us (B.B.) noticed an adult Tiger Snake basking on a dead, fallen eucalypt branch situated approximately 2 m from a well-used path. The branch was raised slightly off the ground, surrounded and partially covered by flattened dead grass. Whilst slowly approaching the Tiger Snake in an attempt to photograph it, an adult Bobtail was observed to be sharing the basking site in very close proximity (*c.* 10 cm.) to the Tiger Snake. Unfortunately, before a photograph could be taken the Tiger Snake took fright and moved off into the surrounding grass. The Bobtail however was unperturbed and remained *in situ*.

Weather was cloudy with sunny patches and humid. Temperature at the time (*c.* 9.00 am) was estimated at 22°C (range 18–27°C; BoM).

Such field compatibility observations are reported occasionally in the literature, and both Maryan & Robinson (1987) and Orange (1992) record instances of snakes and lizards in close proximity (sharing refuges). One of us (P.O.) has previously seen Tiger Snakes basking communally at Herdsman Lake, but this is the first time we have noted a Tiger Snake basking with a potential prey item. Presumably the size of the Bobtail prevented it from being regarded as such.

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– BRUCE BUDREY, Swan View and PAUL ORANGE, Hamersley.

FIRST WESTERN AUSTRALIAN SPECIMEN OF HOUSE SWIFT (*APUS NIPALENSIS*) WITH NOTES ON ITS DISTRIBUTION AND MIGRATION

By R.E. JOHNSTONE[1] and B. GREATWICH[2]

[1]Department of Ornithology, Western Australian Museum, Locked Bag 49 Welshpool DC Western Australia 6986

[2]Department of Biodiversity, Conservation and Attractions, Broome 6725

INTRODUCTION

In early January 2018 with the approach and passing of Cyclone "Joyce" several naturalists (Bruce Greatwich, Nigel Jackett and George Swann) observed an influx of swifts at Broome, Western Australia. On 11 and 12 January mixed flocks of swifts including groups of up to 30 or more House Swifts (*Apus nipalensis*), Pacific Swift (*Apus pacificus*) and at least three Swiftlets (*Collocalia* spp.) were observed at Cable Beach, the Broome Port, Broome water treatment ponds and near Broome Bird Observatory in Roebuck Bay (Figure 1). On 13 January 2018 after the cyclone had passed, one of the observers (B.G.) found a freshly dead House Swift while being seated at his restaurant table, at the Sunset Bar, Cable Beach. The specimen was frozen and sent to the Western Australian Museum where it was prepared into a study skin (registered number A40252) and its identification confirmed as a House Swift *Apus nipalensis subfurcatus* (Blyth 1849), the first specimen for Western Australia.

DESCRIPTION OF THE SPECIMEN

Details of the specimen are as follows:

Juvenile male: total length 141mm; weight 16 g (with no body or subcutaneous fat); exposed culmen 8 mm; entire culmen 13 mm; bill width 9.1 mm; wing 135 mm; tail 50 mm; tail fork 5.2 mm; tarsus 8 mm; middle toe and claw 9 mm. Iris brown; bill black; mouth pinkish white; legs pinkish, toes brownish. Its skull was not fully ossified (juvenile) and testes measured 1.8 *x* 1.8 mm. Forehead crown, hindneck and cheeks greyish brown to blackish brown, some feathers with narrow greyish white tips. Lores blackish. Back and upperwing coverts black with slight blue gloss. Rump band white, most feathers with fine blackish shaft, lower feathers with greyish tips and the white extending slightly onto the flanks creating

Figure 1. House Swift *Apus nipalensis* in flight over Broome (N. Jackett).

a U-shaped patch. Uppertail coverts black with slight bluish gloss and pale edging. Tail blackish the outermost narrowly edged white on outerweb and outer two feathers of same length. Primaries and secondaries blackish brown with blacker outer webs and most secondaries with narrow whitish tips and edging. Wing coverts blackish brown with slightly darker black tips and outer coverts tipped white. Chin and throat greyish white (the patch rounded and reaching the lower throat). Rest of underparts black, the feathers with greyish bases and narrow whitish or greyish white tips. Underwing coverts brownish black with narrow whitish fringes or tips and the greater and median coverts with darker subterminal band. Rest of underwing dark grey (i.e. paler than upperwing). Undertail dark grey. See Figures 2 and 3.

DISTRIBUTION, GEOGRAPHIC VARIATION, STATUS AND MIGRATION

The House Swift occurs over most of South-east Asia from Nepal east to Japan and south to Malaysia and Indonesia includ-

Figure 2. House Swift *Apus nipalensis* A40252 – dorsal view.

Figure 3. House Swift *Apus nipalensis* A40252 – ventral view.

ing Borneo, Sulawesi and some Lesser Sunda Islands.

Four subspecies are currently recognised:

Subspecies *Apus nipalensis nipalensis* occurs from Nepal east to China and south to Assam, Burma, Thailand, Laos, Vietnam and Cambodia. This subspecies has a clear white throat and rump band, wing 128–138 mm and tail 42–49 mm and is slightly less blue-black on the upperparts than the others. This northern population is believed to be migratory.

Subspecies *Apus nipalensis subfurcatus* ranges from the Malay Peninsula south to Sumatra and east to Borneo, Anambas and Biliton islands. It has a rounded whitish throat patch, white rump band with fine but visible dark shaft-streaking and has the outer two tail feathers equal in length, wing 130–140 mm, tail 47–55 mm (depth of tail fork 5–8 mm).

Subspecies *Apus nipalensis kuntzi* from Taiwan. It is a little intermediate in colour between *subfurcatus* and *nipalensis* and has a greyish-white rump with generally more extensive dark shaft streaking, and it has wing length of 124–141 mm.

Subspecies *Apus nipalensis furcatus* occurs on Java and Bali. It is a little paler on underparts compared to the other races and has the deepest tail fork of all subspecies (8.0–13.5 mm) and the outermost rectrices are staggered in length (i.e. t6 is longer than t5), wing 135–144 mm and tail 55–59 mm.

Based on coloration and size, including the rounded, greyish throat patch, blackish upperparts with slight bluish gloss; white rump with most feathers having a dark shaft line; having the outer two rectrices of roughly equal length and depth of tail fork we believe the Broome bird is *Apus nipalensis subfurcatus* from the Malaysia–Indonesia region. Also judging from the pale feather edging, its skull being not fully ossified and small size of testes that it is a just fledged juvenile male. The bird weighed only 16 g, well below the typical 25–32 g of this species. The stomach was completely empty and there was no sign of body or subcutaneous fat indicating that it had died of exhaustion and hunger as a result of the cyclone.

Distribution of *Apus nipalensis* including subspecies is given in Figure 4.

DISCUSSION

Almost nothing is known about the migration and movements of the House Swift except that northern populations are believed to be migratory (Chantler and Driessens 1995). Noteworthy here is the fact that the House Swift appears to be expanding its range and colonising Wallacea (Coates and Bishop 1997).White and Bruce (1986) mention that it became a resident in southern Sulawesi in the 1970s and they concluded that this range expan-

Figure 4. Map showing the distribution of populations.

sion and population explosion was due to the adoption of man-made structures as nesting sites. A breeding colony of 50 birds was recorded on Sumba Island in June 1994. In East Timor (Timor Leste) between 2003–2006, a total of 22 records were noted with breeding colonies of 200 recorded in March 2003 and 100–200 in December 2003. Birds were first observed in February 2003 with flocks of 200 observed at Lautem on 2 and 3 February; small numbers at same place between 8 and 20 November; flock of 200 on 6 December; small flocks (of up to 15) on 21 December; and small flocks (up to 15) at Dili in December 2003. Pairs and small flocks (up to 20) were recorded around Lautem and Dili in April, May and November 2004 and small flocks present in August, September and October 2005 and April 2006 (C. Trainor pers. com.). Birds were recorded breeding at two coastal cliff sites and under a statue near Dili in April 2006. Also single

birds were recorded on Semau Island, off west Timor in August 2012 (Johnstone *et al.* 2014). Despite these recent records of breeding colonies, the species is rarely recorded elsewhere in the Lesser Sundas region. The species may prove to be a breeding visitor to east Timor and this juvenile could well have originated from a recent breeding event on that island.

The subspecific identity of birds occurring in Wallacea has not been established (Eaton *et al.* 2016) but it would appear that they may well be *subfurcatus*, extending from Borneo to Sulawesi and east to Lesser Sundas and Moluccas rather than east from Java and Bali along the Lesser Sundas chain.

The House Swift (*Apus nipalensis*) forms a superspecies with the Little Swift *Apus affinis* of Africa and southern Asia. It is very similar in size and structure, and in the past they were treated as conspecific. Separation of the two species is based mainly on *nipalensis* having a consistently longer, more forked tail, being darker blacker on head and tail and having a narrower white rump band.

The House Swift was first recorded in Australia when an injured bird was picked up at Point Stuart, 120 km south-east of Darwin in Northern Territory (Robertson 1980). This bird later died, was skinned, and is lodged in the Museum of Victoria (Registered No. B12537). Of interest here is that this specimen was a juvenile female, with an unossified skull, no fat deposits, and white edging to many of the feathers indicating that it was also, a recently fledged juvenile (like the Broome bird) and it too was identified as subspecies *subfurcatus*.

In Western Australia, the House Swift is listed as vagrant. Two birds were observed circling a rig in the Timor Sea in November 1988; two observed at Broome in 1998; one observed with Pacific Swifts (Fork-tailed Swifts) and Tree Martins at Broome Port in March 2000; and one associated with Pacific Swifts in April 2011. It is also recorded on Ashmore Reef, and on both Christmas and Cocos (Keeling) islands (Johnstone and Darnell 2017). The flock or loose aggregation of around 30 birds observed at Broome in January 2018 during Cyclone "Joyce" is certainly the largest recorded in Australia.

On 18 February 2018, Cyclone "Kelvin" crossed the coastline south of Broome and House Swifts were again observed in small numbers including an exhausted bird found alive at Broome.

HABITAT

In Asia, the House Swift is often seen around villages, towns, cities, cliffs, rocky outcrops and caves, old forts and ruins. It is recorded breeding most months of the year in colonies with nests placed under the eaves of verandas, in buildings, under

bridges, on cliffs or in caves. Breeding on Timor is recorded in December and March and therefore December would fit well with a January fledgling.

WEATHER

Nearly all Australian records of this species have been associated with cyclones or severe storms.

In early January 2018 a large low pressure system formed in the northern Timor Sea area off eastern Indonesia and moved south towards north-western Australia. As it moved south-east, it reduced in area but intensified in the Timor Sea. It remained in the area further intensifying while moving slowly south-west, and by 10 January it was just off the west Kimberley coast north-west of Broome. By 11 January it had formed into Tropical Cyclone "Joyce" and tracked south-west towards the Pilbara coast with landfall over the Eighty Mile Beach area.

Judging from the weather maps, winds from this low pressure system could have drawn down birds from the Timor area, then once displaced and out of sight of land, these birds would have moved downwind towards the Kimberley coast. See Figure 5.

CONCLUSION

The apparent breeding expansion of this species in eastern Wallacea could well lead to birds colonising parts of west Kimberley where there would appear to be suitable habitat.

This record also highlights the value of specimens in gaining information on these Asian migrants including details of sex, age, condition, morphology and defining their region of origin.

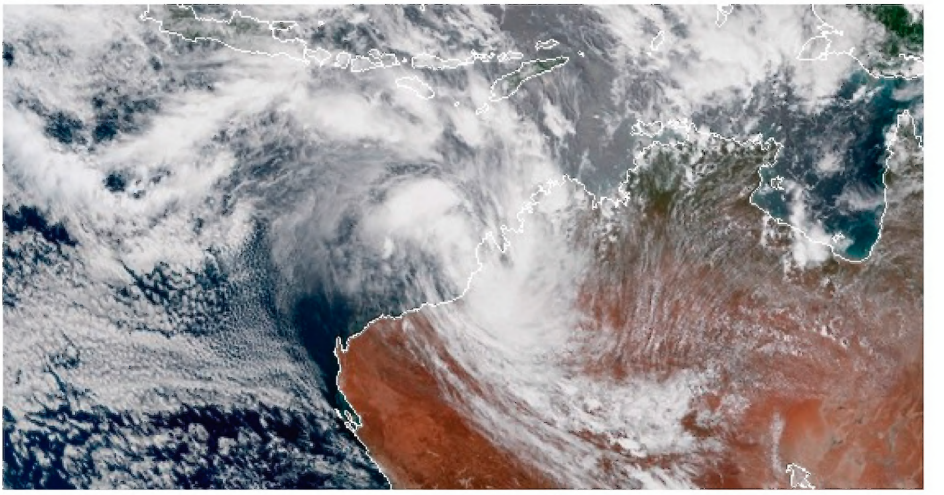

Figure 5. Satellite image of Cyclone "Joyce" crossing west Kimberley coast.

ACKNOWLEDGEMENTS

We are grateful to Kim Sarti for photographing the specimen, help with the manuscript and preparing the distribution map. Nigel Jackett and George Swan helped locate and document the influx of House Swifts around Broome. We also thank John Darnell for comments on the manuscript, Rob Fleming for enhancing the photograph supplied by Nigel Jackett and Colin Trainor for details of Timor Leste records.

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Typeset and printed in Western Australia

Western Australian Naturalists' Club Inc.

ABN 97 932 293 116

Level 2, The Beaufort Centre, 82 Beaufort St, Perth.
Postal Address: PO Box 8257, Perth Business Centre 6849
Telephone: (08) 9228 2495
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